

**DATA-DESIGN LABORATORIES**

Enclosure (1)  
121-695/FH  
Contract AF 41(609)-743  
Project-Task 771906

**FINAL REPORT**

**DEVELOPMENT OF TEST ITEMS  
FOR  
OFFICER SELECTION AND CLASSIFICATION BATTERIES**

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15 September 1966

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Prepared for  
6570th Personnel Research Laboratory  
Aerospace Medical Division (AFSC)  
Lackland Air Force Base

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### ABSTRACT

This report covers the effort of Data-Design Laboratories under Contract AF 41(609)-2743, Project-Task 771906. The contract covers the production of 100 mechanical-principles test items and 50 background-for-world-events test items. Fourteen 50-item tests were submitted for tryouts to groups of officer candidates who scored above the 65th percentile on the Armed Forces Qualification Test. The average group size was 383. Items were scored on difficulty,  $\phi$  for each alternative, and  $\phi$  ratio for the correct alternative.

Considerable difficulty was encountered in obtaining the required number of acceptable questions. It is believed that this difficulty stemmed primarily from the lack of an external criteria and, to a lesser extent, from the statistical tests specified by contract.

These difficulties required an extension of contract schedules and a total of 700 items for development of 150 acceptable items.

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## I. PREFACE

This is the final report describing Data-Design Laboratories' activities under contract AF 41(609)-2743, Project-Task 771906. This report summarizes all activities during the period 15 December 1964 through 15 September 1966.

## II. TASK DESCRIPTION

This task involved the preparation and evaluation of test items to be used in the preparation of officer selection and classification test batteries. A total of 150 fully acceptable items were required: 100 mechanical-principles items and 50 background-for-world-events items. Qualification of the items for acceptability was as follows:

Correlation. A minimum acceptable correlation of the correct alternative with the total test score to be shown by a ratio of 0.45 or more between the obtained correlation (phi coefficient) and the maximum possible phi coefficient for the difficulty of the item. The item statistics were to use a phi coefficient based upon the upper and lower 50% of the sample of examinees.

Distribution of Difficulty Level. The tabulation below shows the required distribution of difficulty level versus percent of total items of each type. Difficulty level was computed as percent answering an item correctly.

<u>Difficulty Level</u>	<u>Percent of Items</u>
70-85	3% or less
60-69	8 to 12%
50-59	25 to 30%
40-49	30 to 35%
30-39	20 to 25%
15-29	5% or less

## III. DESCRIPTION OF WORK ACCOMPLISHED

Following agreement with the Air Force on style and content of the sample questions (Phase I), Data-Design proceeded with development of items (Phase II) for tryouts (Phase III) and statistical analysis (Phase IV). The following paragraphs present details of this process, including preparation of the item statistics.

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Test Booklets. A total of 14 test booklets were prepared during the course of this task (Table 1). Each test booklet consisted of 50 multiple-choice questions, or items, on either background for world events or mechanical principles. The mechanical principles test booklets involved a series of approximately 10 diagrams of devices (mechanisms), with from three to six questions concerning each device. From three to five alternatives were included for each item, with most having either four or five alternatives. The booklets were reproduced (400 copies each) and forwarded to Lackland AFB for tryouts.

Tryouts. The test booklets were administered by Air Force personnel to selected groups of examinees. By contract these examinees ranked in or above the 65th percentile on the Armed Forces Qualification Test, showing above average mentality. Answer sheets from the tryouts were returned to Data-Design Laboratories for scoring and item analysis. Sample size for each test booklet is shown in Table 1.

Item Analysis. The test results were graded and rank-ordered according to number of correct responses on each answer sheet. The median score was located, and the results divided into upper and lower groups. Responses to individual items were then tabulated, percent difficulty and phi-coefficient-ratio computed for each item, and finally, actual phi coefficients computed for the alternatives of each item meeting the qualifications listed previously.

TABLE 1. TEST BOOKLETS

Exam No.	Title	No. Subjects
PL 6501 RC	BWE A	361
PL 6504 RC	BWE B	386
PL 6507 RC	BWE C	379
PL 6510 RC	BWE D	396
PL 6512 RC	BWE E	397
PL 6515 RC	BWE F	391
PL 6516 RC	BWE G	369
PL 6502 RC	MP A	414
PL 6505 RC	MP B	395
PL 6508 RC	MP C	367
PL 6511 RC	MP D	395
PL 6513 RC	MP E	369
PL 6517 RC	MP F	369
PL 6601 RC	MP G	379

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Results. The initial results were disappointing. As noted in the quarterly progress reports, the first few test booklets yielded very small numbers of acceptable items, and that these were in the "very easy" and "very hard" difficulty ranges. Subsequent test booklets continued to yield fewer acceptable items, particularly in the mechanical principles category. A great deal of effort was expended in examining and comparing acceptable versus unacceptable items. In no case was there any discernible difference of wording or style or type which provided helpful direction. During a visit to the contract Research Psychologist (in October 1965) it was learned that a one-for-three or one-for-four ratio of acceptable-to-supplied items was common in his experience.

During the above visit a number of methods for improving the yield from the test booklets were discussed. These methods, which are described below, proved more fruitful and eventually enabled completion of the task.

Method 1. The first method involved purification of the test through elimination of the items which discriminated very poorly; i. e., had low-positive or negative phi coefficients. This procedure worked very well for the background-to-world-events tests.

Methods 2 and 3. These methods involved increasing homogeneity of subject matter and item difficulties, respectively. Neither method was actually tried with the BWE tests, due to success with the first method. Method 3, increasing homogeneity of the item difficulties, provided little improvement in mechanical principles items.

Method 4. This method, which was used only with the mechanical principles test items, involved viewing the test booklet as containing a series of subtests, each concerning a single mechanical device. Method 4 was successful in varying degrees, ranging from 95 percent yield down to about 30 percent yield; the best yield was obtained when the difficulty levels of the items used for a given device were fairly homogenous.

Final Delivery. The acceptable items obtained from the tryout and item analysis process above were typed on provided item submittal cards, each containing, in addition to the item, the item statistics (phi coefficients, phi ratio for the correct alternative, and item difficulty) and required identifying information (test origin, scoring criterion, item number, description of the sample used during tryouts, and the tryout date). Where required, alternative distractors were typed below the item as possible replacements for the few distractors which correlated positively with the criterion. The related artwork for the mechanical principles items were identified on the item cards (MP-1, MP-2, etc). Original artwork, a negative, and two glossy prints of each device were included in the final submittal package in individual envelopes; each envelope was marked with its identification number (again, MP-1, MP-2, etc).